The Use of L-Moments in the Determination of Regional Precipitation Climates

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ABSTRACT

As part of a national study of water management during periods of drought, the U.S. Army Corps of Engineers is underwriting the preparation of a national drought atlas. One of the variables being analyzed for the atlas is precipitation. A statistical technique known as L-moments is the basis for the analysis. Central to the L-moment technique is the aggregation of site-specific precipitation data into homogeneous regions. This paper concerns a methodology for defining regions of similar precipitation climates that are homogeneous with respect to the statistical distribution of annual precipitation. Included are a discussion of the data, of the necessity for regionalization, and of the iterative use of clustering and an L-moment-based homogeneity test to determine the regions.

The methodology resulted in 104 precipitation regions within the continental United States. The number of stations in each region varied from 1 to 97. Problems were encountered mainly in mountainous and in arid areas. They were, however, resolved in all but three regions by examining the orography and/or the data.

1. Introduction

In 1989 the U.S. Army Corps of Engineers was charged with the responsibility of conducting a national study of water management during periods of drought. The first year of the study pointed out that relatively little is known, and less shared, about the probability that droughts of a certain duration or intensity will occur. This ignorance has significant planning impacts. Consequently, a recommendation was made to prepare a national drought atlas that will provide a common base of data about precipitation, streamflow, and a measure of soil moisture.

It was decided early in the planning for the atlas that precipitation should be portrayed in a probabilistic framework. It was also decided to compute probabilities of precipitation amounts using L-moment methodology. L-moments are linear combinations of order statistics. They are summarized below in section 3 and completely described by Hosking (1990).

The statistical methods involve regional analysis. Using "index flood" procedures (Hosking and Wallis 1991; Kite 1988), it is assumed that throughout a region the distribution of precipitation is the same at all sites except for a scale factor that may vary from site to site. A weighted-average regional dimensionless quantile function or growth curve is computed, and the site-specific quantile estimates are obtained by multiplying the site mean (scale factor) by the regional quantile function.

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Since the techniques involve regional analysis, it became necessary to define regions for which data could then be used in the probability computations. This paper concerns a methodology for defining regions of similar precipitation climates that are homogeneous with respect to the statistical distribution of annual precipitation. A statistical test of homogeneity based on L-moments of the precipitation data was used, but the regions were defined from other physical and meteorological variables. This approach was taken to ensure the integrity of the statistical test and also to facilitate judgment of whether the region definitions were reasonable. Included in the paper are a discussion of the data, the necessity for regionalization, and the use of clustering and L-moments to determine the regions.

2. Data

The precipitation dataset consists of monthly totals through 1989 that were observed at 1119 of the National Climatic Data Center's 1219-station U.S. Historical Climatology Network (Karl et al. 1990). Record lengths are at least 60 years and average about 85 years. Other than record length, the criteria for selecting the stations are that no more than 10% of the monthly data are missing, and that no more than 12 consecutive months of data are missing. Since all available data meeting the selection criteria are used, record lengths are not constant among stations.

Both unadjusted and adjusted monthly precipitation totals are contained in the Historical Climatology Network dataset. The unadjusted data are original observations that have undergone quality assurance checks. Missing data have not been estimated and remain missing. The adjusted data are the original observations that have been quality checked and modified from the original data, when necessary, to account for nonclimatic effects and biases such as those caused by changes in station location. Missing data have been estimated so that the dataset is serially complete.

The estimation and modification techniques used in the development of the dataset are based on the concept of making corrections from trends and patterns at neighboring stations. The neighbors, however, are the closest stations *within the network*, and could be large distances away. Meteorologically, precipitation is often a localized phenomenon so that adjustments made on the basis of stations that are not within the localized area are suspect. It was therefore decided to use the unadjusted precipitation data.

Some data are missing so that the unadjusted data are not serially complete. Not only are precipitation totals for some months missing, but some of the monthly totals are the sum of daily values for less than a full month. In addition, Reek et al. (1992) recently determined that a small number (less than 0.07 percent) of the daily precipitation totals, upon which the monthly totals are based, contain errors resulting from incorrect operational data handling processes.

None of the missing unadjusted data were estimated, nor were erroneous data corrected. Data for three sites in Florida and one in New Hampshire were, however, eliminated from the study. Defining regions with these sites led to a partitioning that did not subjectively seem to be climatically justifiable. The documentation associated with the Historical Climatology Network indicated that the data for these sites was suspect; removal of these sites resulted in more climatically appropriate partitions.

It is recognized that the dataset contains a small number of errors as well as precipitation amounts that may be questionable, but a more error-free U.S. monthly precipitation dataset is not available. Because of the length of the records, the constraint that at least 90% of the possible data be available, and the extensive quality assessment processes involved in the compilation of the Historical Climatology Network dataset, it was not considered necessary to estimate missing data nor to correct the small number of identified erroneous data in order to determine representative probability statements. Since L-moment ratios are being used to fit probability distributions, the decision not to estimate missing data is based on Hosking's (1990) assertion that asymptotic biases of L-moment ratios are negligible for sample sizes of 20 or more. Sample sizes in the current study are at least three times higher than the number necessary for achieving negligible biases in the estimates of the ratios, so it was not considered necessary to estimate missing data.

3. L-moments

Central to the regionalization process as well as to the computation of probabilities is the use of L-moments. Moment-based methods have long been established in statistics for relating a probability distribution to an observed dataset. Conventional moments are not always satisfactory in two major respects (Hosking 1990). They do not always impart easily interpreted information about the shape of a distribution (especially skew and kurtosis), and estimates of parameters of distributions fitted by the moments are often less accurate than those obtained by other methods, such as maximum likelihood.

An alternative to conventional moments is L-moments. These can be estimated by linear combinations of order statistics (hence the prefix L). Theoretically, L-moments are able to characterize a wider range of distributions than conventional moments. Practically, they are less subject to bias in estimation, and they approximate their asymptotic normal distribution more closely. The main advantage of L-moments over conventional moments is that L-moments suffer less from the effects of sampling variability; they are more robust to outliers in the data. A unified approach to the use of order statistics for the statistical analysis of univariate probability distributions, based on L-moments, has been developed by Hosking (1990).

If the order statistics of a random sample of size n that has been drawn from the distribution of a real valued random variable X with cumulative distribution function $F(X)$ and quantile function $X(F)$ are

$$X_{1:n} \leqslant X_{2:n} \leqslant \cdots \leqslant X_{n:n}$$

then the L-moments for $r = 1, 2, \cdots$ are

$$\lambda_r \equiv r^{-1} \sum_{k=0}^{r-1} (-1)^k \binom{r-1}{k} EX_{r-k:r}.$$

The expectation of an order statistic is

$$EX_{j:r} = \frac{r!}{(j-1)!(r-j)!} \int X[F(X)]^{j-1} \times [1 - F(X)]^{r-j} dF(X).$$

Hosking (1990) has shown that substituting the expectation into the equation defining the L-moments, expanding the binomials in $F(X)$, and summing the coefficients of each power of $F(X)$ leads to the L-moments being expressed in terms of shifted Legendre polynomials. The resulting first four L-moments are

$$\lambda_1 = EX$$

$$\lambda_2 = \frac{1}{2} E(X_{2:2} - X_{1:2})$$

$$\lambda_3 = \frac{1}{3} E(X_{3:3} - 2X_{2:3} + X_{1:3})$$

$$\lambda_4 = \frac{1}{4} E(X_{4:4} - 3X_{3:4} + 3X_{2:4} - X_{1:4}).$$

The distribution of a real valued random variable X with finite mean is characterized by its L-moments. Thus, a distribution may be specified even if some of its conventional moments do not exist.

The first L-moment is the mean of the distribution. The second is a measure of scale or dispersion. Standardizing higher moments $r > 2$

$$\tau_r = \frac{\lambda_r}{\lambda_2}$$

and defining a function of L-moments analogous to the coefficient of variation (CV),

$$\text{L-CV} = \frac{\lambda_2}{\lambda_1}$$

$$\text{L-skew} = \tau_3 = \frac{\lambda_3}{\lambda_2}$$

$$\text{L-kurtosis} = \tau_4 = \frac{\lambda_4}{\lambda_2}.$$

The four measures, L-location, L-scale, L-skew, and L-kurtosis, can be interpreted analogously to their conventional equivalents, and they are usually the only moments necessary to summarize the main features of a distribution. Equations for parameter estimation via L-moments for the normal, lognormal, exponential, Gumbel, generalized Pareto, generalized extreme value, generalized logistic, Pearson type III, and Wakeby distributions are given by Hosking (1989, 1990).

Although distributions and therefore quantiles can be estimated from L-moments computed from a station's data, Wallis (1989) and Hosking and Wallis (1990) argue that more accurate estimates can be obtained if based on data observed at several sites in a region. Implicit in their argument is that measurements are often available from many sites, that frequently there is little cross correlation between observations, and that there is no obvious physical reason to suggest that the data observed at each site are not random realizations of the same physical process. In other words, if a region is homogeneous in terms of the controlling physical mechanisms, then regional estimates of quantiles will be better than estimates for individual sites; quantiles at individual sites differ from the regional quantiles merely by a scale factor. As shown below, the L-moments computed at individual stations are used to assess the degree of homogeneity among a group of stations.

Because a unified approach to theory has only recently become available, L-moments have been applied to only a few small-scale analyses. For example, Wallis (1989) performed a regional flood frequency analysis for the Appalachian plateau, a depth–duration–frequency study of California annual rainfall, and an analysis of maximum annual wind speed data at 129 U.S. locations. Pilon and Adamowski (1992) studied the value of regional information in flood frequency analyses in Canada. Another study by Angel and Huff (1992) compared estimates of extreme 24-hour rainfall totals for sites in Minnesota and Indiana that were generated from a subjective graphical procedure with those generated from L-moment procedures. They state that there are no meteorological or statistical differences between the methods, that the L-moments yield slightly more conservative estimates, and that the determination of which method is better is difficult to ascertain. They prefer the graphical procedure because it "allows the analyst to incorporate meteorological–climatological knowledge and other pertinent findings," but since they did not describe how their regions were defined, it is not possible to determine if the added knowledge available for the graphical procedure could have been incorporated into the definition of regions, thereby improving the more objective L-moment estimates.

4. Initial formation of regions

Since regional estimates of quantiles should be better than estimates from individual stations, it became necessary to define regions. Intuitively, regions should be homogeneous in terms of the precipitation-amount climatology; the same physical generating processes that define the long-term collective values of precipitation conditions should be operating throughout the region.

The first thought was to use the 23 climate regions defined by Karl et al. (1988) and used by Plantico et al. (1990). Investigation revealed, however, that these regions were based on geographic boundaries for the initial purpose of a temperature analysis, and were therefore unsuitable for this study. Climatic divisions extensively used by the National Climatic Data Center were not used because they are primarily based on agricultural considerations and county boundaries (U.S. Weather Bureau 1949). Regions defined by Koeppen's and Thornthwaite's climate classification systems (Critchfield 1974), as well as by the moisture index described by Mather (1974) as modified by Willmott and Feddema (1992), were determined to be unsuitable because they do not provide enough detail.

Since existing classification schemes did not appear to be satisfactory, it was decided to define regions specifically for the atlas precipitation analyses. Of importance for drought planning are indicators of precipitation amounts, of variability of the amounts throughout the year, and of geographical location. Seven variables were chosen to describe a "precipitation climate": site latitude; longitude; elevation; mean annual precipitation amount; the ratio of the mean precipitation for the two consecutive months with the lowest mean amount in the year to that for the two consecutive months with the highest mean amount; the beginning month of two consecutive months with the highest mean amount in the year, and the beginning month of two consecutive months with the lowest mean amount in the year. Means were computed over the period of record (60 years or more) at each site. The first three variables describe the location, the fourth is self-explanatory, and the fifth, sixth, and seventh describe the average variability of the annual cycle of precipitation.

The objective of the regionalization is to aggregate sites with similar precipitation climates that are statistically homogeneous only with respect to the distribution of precipitation amounts. (The precipitation amount is the variable for which probabilities are computed by fitting distribution functions from L-moments.) Proper use of a homogeneity measure described later dictates that *the regionalization criteria differ from the variable being tested for homogeneity* (Hosking and Wallis 1991; 1992, personal communication).

The regionalization described herein and schematically depicted in Fig. 1 is a two-step iterative procedure. The first step is a clustering of sites based on the seven variables listed above that are of importance to drought planners. This step results in groups of sites with similar precipitation climates that are then tested for homogeneity of mean annual precipitation amounts within a group. If the sites within a group test homogeneous, then the group becomes a distinct region. If the sites within a group test heterogeneous, then the group is reclustered into smaller groups and each subgroup is retested for homogeneity. The iterative process ends when either homogeneity is achieved or when the subgroups appear to display random patterns. Site grouping into physically similar precipitation climates was accomplished with commercial clustering analysis software. The clustering algorithms are used heuristically to provide an output (clusters) that is then subjected to more rigorous analysis (homogeneity testing).

The data were processed using SAS average linkage and Ward's minimum variance hierarchical clustering software (SAS 1988). According to SAS, in the average linkage technique the distance between two clusters is the average Euclidean distance between pairs of observations, one in each cluster. Clusters with small variances tend to be joined, and the procedure is biased toward producing clusters with the same variance. In Ward's minimum variance technique, the Euclidean distance between two clusters is the sum of squares between the two clusters summed over all the variables. The method tends to join clusters with a small number of observations and is strongly biased toward producing clusters with the same number of observations.

Both techniques are based on Euclidean distances and are sensitive to redundant information that may be contained in the variables as well as to the scale of the variables being clustered (Fovell and Fovell 1993). The four variables describing precipitation characteristics are mutually exclusive in terms of the information they are intended to contain. The location variables

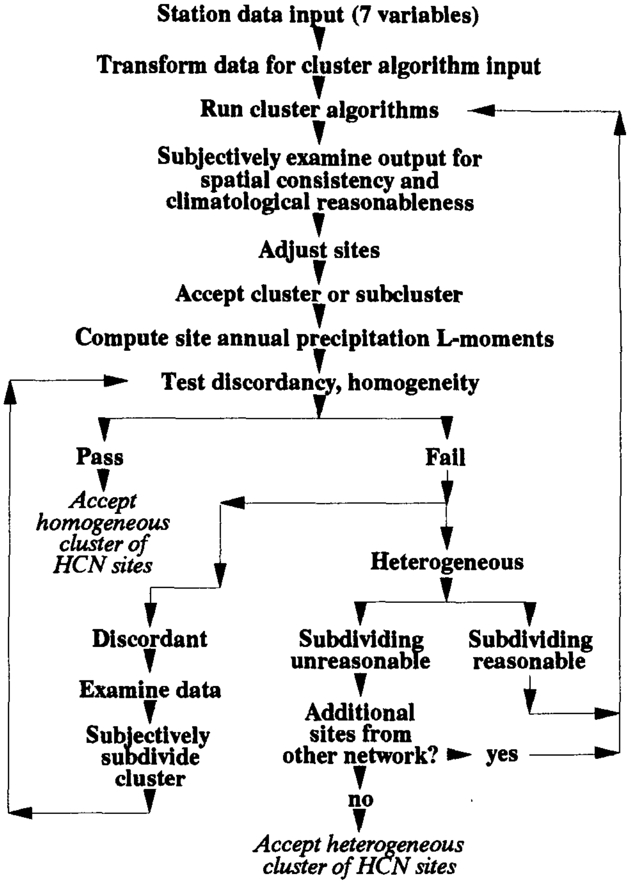

FIG. 1. Schematic flowchart of the regionalization methodology.

may be irrelevant because their information could be contained in the other four variables. They were used, however, as a proxy for differentiating among the controlling, *locally* operating physical mechanisms that produce the precipitation. Under the assumption that precipitation is a localized process, the controlling physical mechanisms should be operating over a localized area so that the precipitation resulting from the process may be expected to fall in a geographically contiguous area. The three location variables were therefore included to encourage the clustering software to group sites with similar precipitation characteristics into spatially continuous regions.

Recognizing that the observed scales of the variables are very different, a rescaling was necessary. The location, precipitation amount, and precipitation ratio variables were rescaled to fall within a range of 0 to 1. Since the other two variables represent a point along an annual cycle, the months were described by a sine curve with a period of 12 months and a range from -1 to $+1$. Table 1 shows the transformations from the seven variables that describe a precipitation climate to the input variables for the clustering algorithms.

TABLE 1. Transformation from data variable X_i to cluster algorithm input variable Y_i.

i	X	Y
1	Latitude (deg)	$Y = X/90$
2	Longitude (deg)	$Y = X/150$
3	Elevation (ft)	$Y = X/10\,000$
4	Mean annual precipitation (in.)	$Y = X/100$
5	Ratio of minimum average two-month total precipitation to maximum average two-month precipitation	$Y = X$
6	Beginning month $j = 1, \cdots, 12$ of minimum average two-month precipitation	$Y = \sin(2\pi j/12)$
7	Beginning month $j = 1, \cdots, 12$ of maximum average two-month precipitation	$Y = \sin(2\pi j/12)$

Remembering that the purpose of the clustering was to produce a set of stations for which each station in the set responds to the same physical controlling processes, that is, all stations in the set exhibit the same precipitation climate (as defined by the variables upon which the clustering is based), and also for which the set is homogeneous solely with respect to annual precipitation amounts (a requirement for the follow-on precipitation probability analyses), it was known a priori that the areal extent of a region would be relatively small. As a matter of personal computing convenience (limited personal computer disk space), the contiguous United States was split into four overlapping quadrants. The sites in each quadrant were then clustered.

The output from both the average linkage and Ward's methods was very similar. For each quadrant, 2 through 14 clusters were subjectively reviewed to insure spatial continuity and physical reasonableness. The overlap areas between adjacent quadrants were also examined to ensure consistency of results from the separate quadrant cluster analyses. Cluster members were occasionally moved to other clusters to meet the spatial continuity requirements. The review resulted in an initial regionalization consisting of between 7 and 11 clusters per quadrant; most of the clusters were large in areal extent. These clusters were subjectively determined to be reasonable in the sense that they depicted areas that could easily be justified on basis of controlling physical processes. Retaining additional clusters could not easily be justified on this basis.

The approach uses the clustering software in a nonstandard and somewhat subjective manner. The use of location variables may be irrelevant, the rescaling of the variables was arbitrary, splitting the United States into four overlapping quadrants was arbitrary, and the sine function transformation of months is not a one-to-one mapping. In addition, subjective decisions were made concerning the number of clusters to retain from the SAS output, spatial continuity, the movement of sites from one cluster to another, and the assessment of similarity between the outputs from the average linkage and Ward's clustering methods. Although more rigorous statistical or meteorological analyses could have been undertaken to describe or define the physical controlling processes, the approach follows the preferences of Angel and Huff (1992) by mixing mathematical algorithms with climatological judgment. It was also near-completely successful for solving the practical climatological application problem specific to the requirements of the *National Drought Atlas* in that all but three of the resulting clusters were objectively verified for homogeneity by L-moment tests.

5. Testing and modification of regions

Homogeneity of annual precipitation amounts within a region was evaluated by using L-moment techniques. Scatterplots of L-CV and L-skew versus L-kurtosis show compact groupings when the data are homogeneous (Wallis 1989). Defining a compact grouping, however, is rather subjective. Because of this quandary, more objective guidelines were developed to assess homogeneity (Hosking and Wallis 1991). Given a region, a discordancy measure based on the individual site L-CV, L-skew, and L-kurtosis vector difference from the region centroid identifies those sites that are grossly different from the region as a whole. It is a guideline rather than a formal statistical test because the data are not assumed to come from identical multivariate distributions. A homogeneity measure estimates the degree of heterogeneity within a group of sites. This measure assumes that in a homogeneous region, all sites will have the same population L moments, but that sample L moments will differ because of sampling variability. It compares the dispersion of the observed L-CVs at the sites to the dispersion that would be expected in a homogeneous region; the expected dispersion is obtained through simulation.

The discordancy and homogeneity measures were computed for each of the initial regions defined by the cluster analyses. If the homogeneity test showed a cluster to be heterogeneous, the stations in the cluster were separated by the clustering algorithms into smaller groupings. This iterative procedure ended when the smaller groupings either were homogeneous or appeared to display random geographical patterns and could not be justified on physical grounds. At this point, the homogeneity and discordancy measures for the stations within a cluster were generally acceptable. There were, however, some problem areas.

Occasionally, several neighboring stations in one of the initial clusters were all discordant. This situation was easily handled by forming a new cluster of the discordant stations. The homogeneity and discordancy tests indicated that these new clusters were acceptable.

In the West, the cluster analyses resulted in several heterogeneous regions. This situation was expected because of the orography of the area. By either moving stations at the edge of a region into a neighboring region or by moving stations into regions with similar orographic characteristics, it was found that acceptably homogeneous regions could be defined. In the arid areas of the Rockies and the Southwest, acceptable regions were defined mainly on the basis of mean annual precipitation.

The minor modifications to the cluster algorithm groupings of stations removed most of the heterogeneity identified by the L-moment tests. For the remaining heterogeneous regions in the Los Angeles Basin, Olympic peninsula, and central Rockies, data from the National Climatic Data Center's Cooperative Observer Network Data Set TD-3200 were used to supplement the Historical Climatology Network (HCN) data. For each of these heterogeneous regions, the TD-3200 data, which have not been subjected to the same degree of quality assurance as the HCN data and also which did not necessarily meet the restrictions described in section 2, were combined with the HCN data. Reclustering and retesting of these combined datasets led to a redefinition of regions (consisting of only the HCN sites and not the TD-3200 sites) in the Los Angeles Basin. Even with the supplemental information contained in the TD-3200 data, homogeneous regions of HCN sites could not be defined in the Olympic peninsula, Nevada, or central Colorado. These regions (numbers 59, 84, and 19 in Fig. 2) remain heterogeneous.

The iterative process of reclustering regions, evaluating spatial continuity and physical reasonableness of the new clusters, and assessing the discordancy and homogeneity measures for the new clusters led to defining the 104 regions shown in Fig. 2. A list of stations, region numbers, beginning and ending years of record, and the numbers of observations are given in the Appendix.

6. Discussion

Both the cluster algorithms and the homogeneity testing assume stationarity and interannual independence. The possibility of periodic or trend behavior in the data is recognized but was not considered in this study. In a subsequent analysis by Guttman et al. (1993), however, annual precipitation was split into four 22-year segments from 1902 to 1989. The mean and L-CV for these four periods were computed and examined to identify patterns in relative changes from one time period to the next. Analyses were also made of the changes of the 0.50 and 0.05 quantile values. Consistent trends were not evident in any of the variables analyzed.

From a climatological view, the 104 regions resulting from this study may be considered excessive. Rigorous

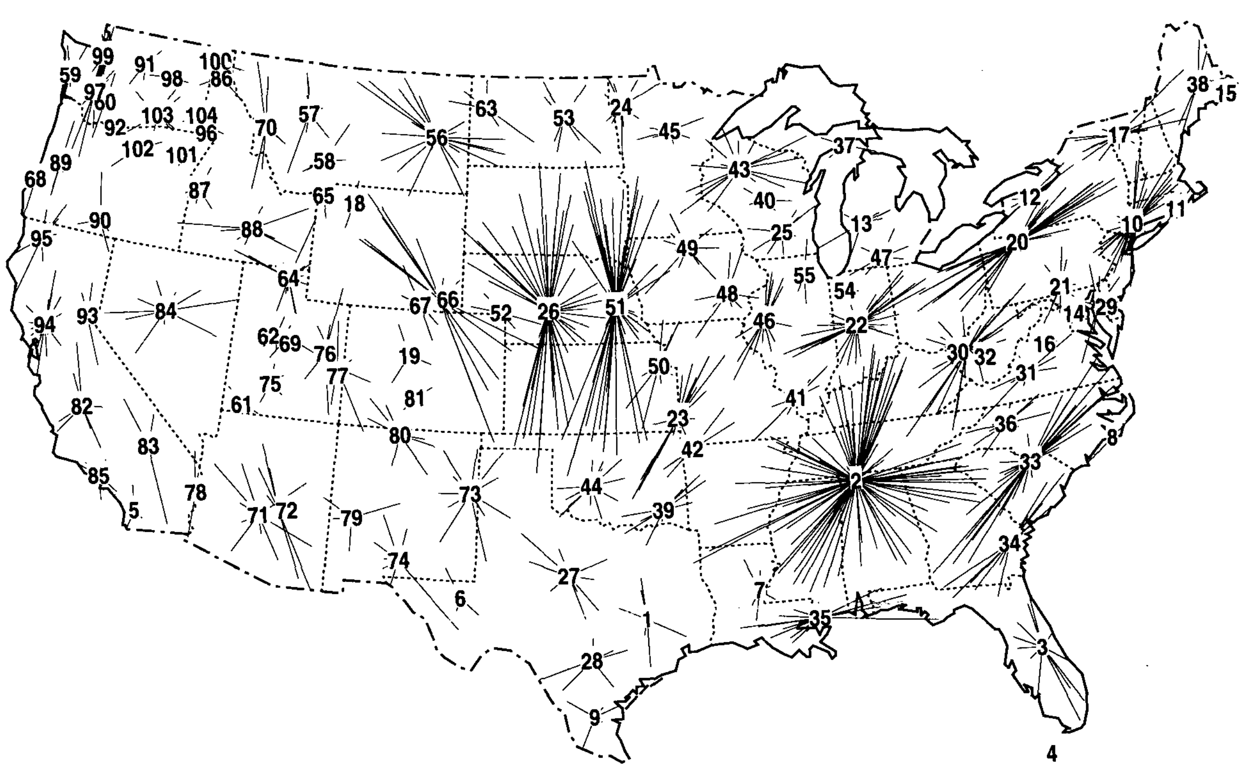

FIG. 2. Precipitation regions. The number in the centroid of a region identifies the region; lines radiating from the centroid end at the location of stations within a region.

cluster analysis alone has been successfully used in numerous studies for grouping sites with similar climates into regions with larger areal extent than shown in Fig. 2. The groups were subdivided in this study, however, for the specific purpose of obtaining regions that meet the statistical requirements for the subsequent application of L-moment methodology to the computation of probability estimates.

Although not examined, resampling schemes could possibly (and would probably) lead to different regions. The use of additional or different observing sites, and the use of different variables to define a "precipitation climate" would likely change the regionalization. The regions presented in Fig. 2 were constructed for the specific application of computing precipitation quantile values for the *National Drought Atlas*. Robustness of the regions for other purposes is not addressed in this study; if the regions are to be used in other applications, an evaluation of the assumptions and methodology with respect to the intended application is strongly encouraged.

7. Conclusions

The regionalization methodology described in this paper is objective in the sense that clustering algorithms, L-moment computation, discordancy, and homogeneity testing are strictly mathematical. Interpretation of the results, however, requires human intervention. Crucial to the procedure is the definition, based on physical reasoning, of what constitutes a precipitation climate. Also crucial is the examination of the data and the processes leading to the observations so that causes of heterogeneity can be identified. The human intervention thus links the analyst's knowledge of the underlying physical mechanisms, nonclimatic systematic biases, or other appropriate information to the mathematical techniques.

As the homogeneity within a region increases, the confidence that can be placed on quantiles from probability distributions derived from regionally weighted L-moments increases. Regions were determined from analyses of data collected from a relatively sparse spatial network of stations. It is suggested, therefore, that improved probability assessments could be made by defining regions that are based on a homogeneity analysis of data from a denser spatial network of sites.

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APPENDIX

Station List

Station list by region with beginning year of record, ending year of record, and number of observations.

Region	Station	Begin	End	Number	Region	Station	Begin	End	Number
1	TX Brenham	1885	1989	100	2	AR Prescott	1882	1989	95
1	TX Corsicana	1874	1989	107	2	GA Covington	1893	1989	96
1	TX Danevang	1896	1989	92	2	GA Dahlonega	1892	1989	97
1	TX Liberty	1903	1989	85	2	GA Gainesville	1872	1989	108
1	TX Mexia	1904	1989	85	2	GA Newnan	1882	1989	93
1	TX Temple	1882	1989	100	2	GA Rome	1855	1989	132
2	AL Gainsville	1893	1989	97	2	GA Talbotton	1892	1989	94
2	AL Greensboro	1884	1989	105	2	GA Toccoa	1882	1989	97
2	AL Highland Home	1892	1989	96	2	GA Warrenton	1884	1989	90
2	AL Scottsboro	1890	1989	95	2	GA Washington	1884	1989	97
2	AL Selma	1882	1989	97	2	GA West Point	1882	1989	91
2	AL St. Bernard	1907	1989	81	2	IL Harrisburg	1898	1988	91
2	AL Talladega	1897	1989	92	2	IN Charlestown	1900	1989	85
2	AL Thomasville	1891	1989	99	2	IN Columbus	1884	1989	106
2	AL Troy	1908	1989	81	2	IN Madison	1893	1989	95
2	AL Tuscaloosa	1881	1989	109	2	IN Mt. Vernon	1887	1989	102
2	AL Union Springs	1868	1989	120	2	IN Paoli	1898	1989	89
2	AL Valley Head	1885	1989	102	2	IN Princeton	1882	1989	104
2	AR Brinkley	1882	1989	98	2	IN Scottsburg	1894	1989	95
2	AR Conway	1884	1989	104	2	IN Seymour	1887	1989	100
2	AR Corning	1892	1989	95	2	IN Vevay	1865	1989	122
2	AR Newport	1884	1989	99	2	KY Bowling Green	1886	1989	102
2	AR Pine Bluff	1884	1989	99	2	KY Frankfort	1895	1989	94
2	AR Pocahontas	1894	1989	95	2	KY Greensburg	1887	1989	102

Region	Station	Begin	End	Number
2	KY Hopkinsville	1896	1989	93
2	KY Leitchfield	1895	1989	94
2	KY Owensboro	1896	1989	91
2	KY Shelbyville	1888	1989	99
2	KY Williamstown	1902	1989	87
2	LA Plain Dealing	1892	1989	98
2	LA St. Joseph Exp Stn	1927	1989	62
2	MS Aberdeen	1882	1989	91
2	MS Batesville	1882	1989	101
2	MS Booneville	1896	1989	92
2	MS Brookhaven City	1882	1989	101
2	MS Canton	1882	1989	105
2	MS Clarksdale	1907	1989	81
2	MS Columbia	1903	1989	85
2	MS Columbus	1875	1989	113
2	MS Corinth City	1883	1989	90
2	MS Crystal Springs Exp Stn	1892	1989	96
2	MS Forest	1882	1989	94
2	MS Greenville	1888	1989	102
2	MS Hattiesburg	1897	1989	92
2	MS Holly Springs	1884	1989	95
2	MS Laurel	1902	1989	84
2	MS Louisville	1888	1989	99
2	MS Monticello	1907	1989	82
2	MS Moorhead	1913	1989	75
2	MS Pontotoc Exp Stn	1889	1989	100
2	MS Port Gibson	1885	1989	96
2	MS State Univ	1884	1989	102
2	MS University	1884	1989	95
2	MS Water Valley	1886	1989	103
2	MS Waynesboro	1882	1989	95
2	MS Yazoo City	1886	1989	104
2	MO Caruthersville	1899	1989	88
2	MO Doniphan	1904	1989	85
2	NC Highlands	1909	1989	77
2	NC Waynesville	1894	1989	86
2	SC Anderson	1892	1989	98
2	SC Calhoun Falls	1892	1989	97
2	SC Clemson	1892	1989	98
2	SC Greenwood	1895	1989	95
2	SC Laurens	1918	1989	71
2	SC Walhalla	1916	1989	73
2	TN Clarksville	1888	1989	101
2	TN Copperhill	1914	1989	73
2	TN Covington	1883	1989	102
2	TN Dickson	1900	1989	85
2	TN Dover	1898	1989	90
2	TN Jackson Exp Stn	1891	1989	96
2	TN Lewisburg Exp Stn	1898	1989	91
2	TN McMinnville	1895	1989	94
2	TN Murfreesboro	1882	1989	107
2	TN Tullahoma	1893	1989	94
2	TN Union City	1905	1989	81
2	TN Waynesboro	1884	1989	103
2	TX Marshall	1908	1989	78
3	FL Bartow	1887	1989	101
3	FL Belle Glade Exp Stn	1924	1989	65
3	FL Federal Pt	1892	1989	96
3	FL Fernandina Beach	1901	1989	87
3	FL Fort Lauderdale	1912	1989	76
3	FL Fort Myers	1891	1989	99
3	FL Fort Pierce	1901	1989	87
3	FL Inverness	1927	1989	62
3	FL Ocala	1889	1989	97
3	FL Perrine	1910	1989	74
3	FL Saint Leo	1895	1989	95
3	FL Titusville	1901	1989	84
3	GA Brunswick	1914	1989	74
4	FL Key West	1870	1989	120
5	CA Chula Vista	1918	1989	71
5	CA Cuyamaca	1887	1989	102
5	CA Redlands	1889	1989	101
6	NM Carlsbad	1894	1989	96
6	TX Balmorhea	1923	1989	64
6	TX Ft Stockton	1894	1989	92
7	LA Bunkie	1882	1989	94
7	LA Calhoun Exp Stn	1889	1989	100
7	LA Grand Coteau	1885	1989	104
7	LA Winnsboro	1926	1989	61
7	MS Natchez	1884	1989	102
7	MS Woodville	1893	1989	94
8	NC Hatteras	1874	1989	115
8	NC Morehead City	1905	1989	83
8	NC Southport	1871	1989	119
9	TX Alice	1911	1989	75
9	TX Corpus Christi	1887	1989	102
9	TX Encinal	1907	1989	80
9	TX Falfurrias	1907	1989	82
9	TX Rio Grande City	1912	1989	75
10	CT Falls Village	1889	1989	99
10	CT Stamford	1892	1989	97
10	CT Storrs	1922	1989	68
10	DE Wilmington Porter Rsvr	1894	1989	95
10	MA Amherst	1835	1989	154
10	MA Bedford	1890	1989	96
10	MA Blue Hill Observatory	1885	1989	104
10	MA Framingham	1884	1989	105
10	MA Lawrence	1885	1989	104
10	MA Taunton	1874	1989	115
10	NH Durham	1892	1989	95
10	NH Hanover	1862	1989	126
10	NH Keene	1893	1989	97
10	NJ Atlantic City	1874	1989	115
10	NJ Belvidere	1891	1989	97
10	NJ Boonton	1907	1989	82
10	NJ Charlotteburg	1893	1989	96
10	NJ Flemington	1898	1989	89
10	NJ Hightstown	1891	1989	90
10	NJ Long Branch Oakhurst	1928	1989	62
10	NJ Moorestown	1865	1989	122
10	NJ New Brunswick	1854	1989	136
10	NJ Plainfield	1919	1989	69
10	NY Mohonk Lake	1896	1989	94
10	NY New York Central Park	1836	1989	153
10	NY Port Jervis	1890	1989	99
10	NY Poughkeepsie	1928	1989	60
10	NY Scarsdale	1904	1989	85
10	NY Setauket	1885	1989	104

Region	Station	Begin	End	Number
10	NY Walden	1922	1989	68
10	NY West Point	1905	1989	80
10	NY Yorktown Hts	1888	1989	100
10	PA Allentown	1912	1989	78
10	PA Palmerton	1917	1989	71
10	PA Stroudsburg	1927	1989	62
10	VT Cavendish	1903	1989	86
11	CT Groton	1871	1989	117
11	MA New Bedford	1813	1989	176
11	MA Plymouth	1886	1989	101
11	NY Bridgehampton	1930	1989	59
11	RI Block Island	1880	1989	109
11	RI Kingston	1889	1989	100
11	RI Providence	1831	1989	158
12	NY Buffalo	1858	1989	132
12	NY Fredonia	1914	1989	76
12	NY Lockport	1891	1989	98
12	NY Lowville	1889	1989	100
12	NY Oswego	1861	1989	129
12	NY Rochester	1829	1989	160
12	NY Watertown	1891	1989	99
12	PA Erie	1873	1989	116
13	MI Alma	1887	1989	103
13	MI Big Rapids	1896	1989	93
13	MI Hart	1887	1989	97
13	MI Midland	1907	1989	80
13	MI Mt Pleasant	1915	1989	71
13	MI South Haven	1895	1989	88
13	WI Racine	1896	1989	92
14	MD Glen Dale Bell Station	1921	1989	69
14	MD Laurel	1895	1989	94
14	MD Owings Ferry Landing	1917	1989	70
15	ME Acadia Park	1926	1989	61
15	ME Eastport	1870	1989	118
16	VA Charlottesville	1892	1989	98
16	VA Dale	1880	1989	109
16	VA Piedmont Rsrch Stn	1907	1989	81
16	VA Staunton	1925	1989	64
17	ME Farmington	1889	1989	99
17	ME Gardiner	1893	1989	96
17	ME Ripogenus Dam	1925	1989	64
17	NH Bethlehem	1892	1989	95
17	NY Canton	1905	1989	85
17	NY Dannemora	1906	1989	83
17	NY Indian Lake	1899	1989	89
17	NY Lake Placid	1909	1989	79
17	NY Ogdenburg	1891	1989	94
17	NY Stillwater Reservoir	1921	1989	64
17	NY Tupper Lake Sunmount	1925	1989	64
17	NY Wanakena Ranger Schl	1910	1989	79
17	VT Burlington	1871	1989	118
17	VT Chelsea	1895	1989	94
17	VT Cornwall	1886	1989	94
17	VT St Johnsbury	1894	1989	95
18	MT Red Lodge	1903	1989	87
18	WY Buffalo Bill Dam	1905	1989	85
18	WY Dubois	1905	1989	82
19	CO Cheesman	1902	1989	87
19	CO Dillon	1909	1989	80
19	CO Gunnison	1893	1989	96
19	CO Steamboat Springs	1908	1989	80
20	NY Albany	1874	1989	116
20	NY Alfred	1910	1989	78
20	NY Allegany State Park	1924	1989	65
20	NY Angelica	1888	1989	99
20	NY Bath	1890	1989	96
20	NY Binghamton	1890	1989	99
20	NY Cooperstown	1854	1989	131
20	NY Cortland	1892	1989	97
20	NY Elmira	1889	1989	99
20	NY Geneva Rsrch Farm	1882	1989	107
20	NY Gloversville	1892	1989	96
20	NY Hemlock	1898	1989	90
20	NY Ithaca	1874	1989	115
20	NY Little Falls City Rsvr	1897	1989	92
20	NY Little Falls Mill St	1920	1989	69
20	NY Norwich	1906	1989	81
20	NY Penn Yan	1927	1989	59
20	NY Sarotoga Springs	1903	1989	86
20	NY Syracuse	1902	1989	87
20	OH Bucyrus	1893	1989	94
20	OH Cadiz	1903	1989	84
20	OH Chippewa Lk	1895	1989	94
20	OH Coshocton	1908	1989	81
20	OH Delaware	1896	1989	93
20	OH Hiram	1884	1989	105
20	OH Kenton	1903	1989	86
20	OH Millport	1892	1989	96
20	OH Norwalk	1894	1989	95
20	OH Oberlin	1882	1989	106
20	OH Philo	1895	1989	94
20	OH Urbana	1896	1989	94
20	OH Warren	1892	1989	97
20	OH Wooster	1887	1989	102
20	PA Franklin	1897	1989	93
20	PA Greenville	1903	1989	84
20	PA New Castle	1904	1989	84
20	PA Ridgway	1913	1989	74
20	PA Towanda	1894	1989	95
20	PA Warren	1885	1989	105
20	PA Wellsboro	1905	1989	85
20	WV Wellsburg	1899	1989	89
21	MD Westminster	1921	1989	69
21	PA Chambersburg	1921	1989	69
21	PA Eisenhower Natl Hist	1903	1989	86
21	PA Harrisburg	1889	1989	101
21	PA Selinsgrove	1888	1989	99
21	PA St College	1887	1989	103
21	PA Williamsport	1895	1989	94
21	PA York	1915	1989	74
21	VA Lincoln	1901	1989	88
21	VA Woodstock	1896	1989	93
21	WV Martinsburg	1891	1989	97

Region	Station	Begin	End	Number
22	IL Carlinville	1891	1989	98
22	IL Charleston	1896	1989	94
22	IL Danville	1910	1989	79
22	IL Decatur	1892	1989	96
22	IL Hillsboro	1895	1989	94
22	IL Hoopeston	1902	1989	86
22	IL Palestine	1882	1989	106
22	IL Pana	1898	1989	90
22	IL Paris	1892	1989	93
22	IL Urbana	1888	1989	101
22	IL Windsor	1904	1989	86
22	IN Anderson	1895	1989	94
22	IN Berne	1910	1989	80
22	IN Brookville	1925	1989	64
22	IN Cambridge City	1892	1989	97
22	IN Crawfordsville	1910	1989	75
22	IN Delphi	1885	1989	103
22	IN Greencastle	1915	1989	73
22	IN Greenfield	1903	1989	86
22	IN Huntington	1887	1989	101
22	IN Marion	1885	1989	104
22	IN Oolitic Purdue Exp Farm	1918	1989	71
22	IN Rockville	1887	1989	100
22	IN Rushville	1881	1989	109
22	IN Shoals	1911	1989	79
22	IN Vincennes	1887	1989	101
22	IN Washington	1896	1989	92
22	IN Whitestown	1896	1989	93
22	OH Findlay	1886	1989	103
22	OH Greenville	1886	1989	103
22	OH Napoleon	1885	1989	102
22	OH Tiffin	1885	1989	105
22	OH Upper Sandusky	1882	1989	107
22	OH Wauseon	1874	1989	115
23	KS Columbus	1890	1989	97
23	KS Fort Scott	1889	1989	95
23	KS Independence	1872	1989	118
23	MO Appleton City	1889	1989	98
23	MO Brunswick	1890	1989	98
23	MO Clinton	1906	1989	81
23	MO Lamar	1892	1989	98
23	MO Lee's Summit	1878	1989	111
23	MO Lexington	1892	1989	97
23	MO Lockwood	1904	1989	85
23	MO Moberly	1899	1989	89
23	MO Neosho	1893	1989	96
23	MO Sweet Springs	1923	1989	66
23	MO Truman Dam	1892	1989	96
23	OK Ada	1907	1989	80
23	OK Claremore	1915	1989	73
23	OK Holdenville	1901	1989	86
23	OK Miami	1917	1989	71
23	OK Okemah	1912	1989	76
23	OK Okmulgee	1903	1989	86
24	MN Ada	1916	1989	72
24	MN Baudette	1909	1989	79
24	MN Fosston	1909	1989	78
24	MN Hallock	1899	1989	90
24	MN Roseau	1909	1989	79
24	ND Grafton	1891	1989	99
24	ND Grand Forks	1889	1989	100
24	ND Hillsboro	1905	1989	83
24	ND Mayville	1896	1988	90
24	ND Pembina	1898	1989	92
24	ND Wahpeton	1909	1989	81
25	WI Brodhead	1897	1989	92
25	WI Darlington	1910	1989	76
25	WI Fond Du Lac	1886	1989	104
25	WI Lancaster	1921	1989	67
25	WI Manitowoc	1861	1989	128
25	WI Oshkosh	1888	1989	101
25	WI Portage	1887	1989	102
25	WI Viroqua	1891	1989	95
25	WI Watertown	1891	1989	97
26	KS Ashland	1888	1989	101
26	KS Coldwater	1906	1989	83
26	KS Hays	1867	1989	122
26	KS Jetmore	1901	1989	88
26	KS Lakin	1889	1989	97
26	KS Larned	1904	1989	85
26	KS Liberal	1907	1989	82
26	KS Norton	1903	1989	86
26	KS Phillipsburg	1891	1989	96
26	KS Scott City	1906	1989	83
26	KS Wakeeney	1883	1989	106
26	NE Albion	1910	1989	80
26	NE Alliance	1895	1989	88
26	NE Atkinson	1906	1989	78
26	NE Beaver City	1890	1989	97
26	NE Broken Bow	1895	1989	95
26	NE Franklin	1888	1989	102
26	NE Genoa	1875	1989	114
26	NE Gothenburg	1894	1989	95
26	NE Halsey	1903	1989	86
26	NE Harrison	1914	1989	73
26	NE Hastings	1895	1989	93
26	NE Hay Springs	1886	1989	104
26	NE Holdrege	1890	1989	99
26	NE Loup City	1894	1989	94
26	NE McCook	1892	1989	93
26	NE Merriman	1917	1989	71
26	NE Minden	1878	1989	110
26	NE North Loup	1890	1989	100
26	NE Oakdale	1888	1989	101
26	NE Purdum	1902	1989	85
26	NE Red Cloud	1892	1989	96
26	NE Saint Paul	1896	1989	93
26	NE York	1890	1989	99
26	ND Fort Yates	1926	1989	64
26	OK Beaver	1896	1989	87
26	OK Goodwell Rsrch Stn	1910	1989	80
26	OK Hooker	1906	1989	81
26	SD Cottonwood	1909	1989	79
26	SD Dupree	1922	1989	68
26	SD Eureka	1908	1989	81
26	SD Faulkton	1899	1989	90
26	SD Gann Valley	1886	1989	102
26	SD Highmore	1890	1989	97
26	SD Hot Springs	1908	1989	81
26	SD Kennebec	1892	1989	96
26	SD Murdo	1907	1989	76
26	SD Pierre	1868	1989	121
26	SD Rapid City	1888	1989	100
26	TX Miami	1905	1989	82

Region	Station	Begin	End	Number	Region	Station	Begin	End	Number
26	WY Newcastle	1918	1989	72	31	VA Lexington	1889	1989	101
27	TX Albany	1901	1989	86	31	VA Rocky Mount	1894	1989	95
27	TX Ballinger	1895	1989	92	32	WV Gary	1917	1989	72
27	TX Brownwood	1896	1989	90	32	WV Spencer	1906	1989	83
27	TX Crosbyton	1886	1989	103	32	WV Winfield	1904	1989	85
27	TX Dublin	1921	1989	65	33	GA Albany	1882	1989	98
27	TX Haskell	1890	1989	96	33	GA Blakely	1882	1989	96
27	TX Lampasas	1894	1989	95	33	GA Eastman	1882	1989	86
27	TX Llano	1891	1989	98	33	GA Hawlinsville	1892	1989	95
27	TX Synder	1911	1989	75	33	GA Milledgeville	1901	1989	88
27	TX Weatherford	1883	1989	95	33	GA Millen	1882	1989	95
28	TX Boerne	1892	1989	98	33	GA Tifton Exp Stn	1922	1989	67
28	TX Beeville	1895	1989	95	33	NC Albemarle	1911	1989	78
28	TX Blanco	1896	1989	93	33	NC Edenton	1896	1989	94
28	TX Catarina	1910	1989	79	33	NC Elizabeth City	1911	1989	77
28	TX Eagle Pass	1889	1989	99	33	NC Fayetteville	1889	1989	99
28	TX Flatonia	1908	1989	82	33	NC Goldsboro	1890	1989	97
28	TX Luling	1882	1989	100	33	NC Henderson	1893	1989	96
28	TX New Braunfels	1888	1989	100	33	NC Kinston	1924	1989	65
28	TX San Antonio	1885	1989	105	33	NC Louisburg	1891	1989	98
29	DE Dover	1919	1989	70	33	NC Lumberton	1882	1989	100
29	DE Greenwood	1892	1989	98	33	NC Monroe	1896	1989	94
29	MD Baltimore	1893	1989	97	33	NC Smithfield	1889	1989	98
29	MD College Park	1889	1989	100	33	NC Tarboro	1877	1989	112
29	MD Denton	1895	1989	89	33	NC Wilson	1904	1989	85
29	MD Patuxent Rvr	1892	1989	98	33	SC Aiken	1902	1989	87
29	MD Royal Oak	1891	1989	98	33	SC Blackville	1884	1989	95
29	MD Salisbury	1906	1989	81	33	SC Camden	1849	1989	140
29	NJ Indian Mills	1901	1989	87	33	SC Cheraw	1883	1989	102
29	PA Reading	1877	1989	112	33	SC Columbia	1882	1989	108
29	PA West Chester	1860	1989	129	33	SC Darlington	1895	1989	92
29	VA Hopewell	1916	1989	71	33	SC Kershaw	1916	1989	69
30	KY Ashland	1882	1989	107	33	SC Little Mtn	1893	1989	96
30	KY Berea	1901	1989	87	33	SC Newberry	1887	1989	102
30	KY Farmers	1904	1989	81	33	SC Orangeburg	1916	1989	73
30	KY Middlesboro	1902	1989	81	33	SC Saluda	1902	1989	87
30	KY Williamsburg	1887	1989	101	33	SC Santuck	1893	1989	94
30	MD Cumberland	1871	1989	118	33	SC Sumter	1929	1989	60
30	MD Oakland	1903	1989	85	33	SC Winnsboro	1919	1989	69
30	OH Circleville	1887	1989	99	33	SC Winthrop College	1900	1989	90
30	OH Hillsboro	1908	1989	81	33	VA Norfolk	1909	1989	78
30	OH McConnelsville	1884	1989	105	33	VA Williamsburg	1900	1989	89
30	OH Portsmouth	1830	1989	159	34	FL Lake City	1889	1989	99
30	OH Waverly	1883	1989	106	34	FL Madison	1903	1989	84
30	PA Johnstown	1885	1989	103	34	FL Tallahassee	1885	1989	104
30	PA Uniontown	1888	1989	100	34	GA Bainbridge	1885	1989	88
30	TN Crossville	1912	1989	76	34	GA Glennville	1904	1989	85
30	TN Newport	1891	1989	98	34	GA Quitman	1882	1989	101
30	TN Rogersville	1884	1989	105	34	GA Savannah	1871	1989	119
30	WV Buckhannon	1908	1988	80	34	GA Waycross	1882	1989	93
30	WV Cairo	1900	1989	86	34	SC Beaufort	1886	1989	102
30	WV Glenville	1887	1989	101	34	SC Charleston	1832	1989	158
30	WV Mannington	1901	1989	88	34	SC Conway	1888	1989	99
30	WV Pickens	1902	1989	84	34	SC Kingstree	1882	1989	96
30	WV Williamson	1900	1989	86	34	SC Summerville	1898	1989	89
31	NC Banner Elk	1907	1989	81	34	SC Yemassee	1895	1989	92
31	VA Blacksburg	1891	1989	98	35	AL Brewton	1926	1989	62
31	VA Bremo Bluff	1898	1989	88	35	AL Fairhope	1918	1989	70
31	VA Burkes Grdn	1896	1989	94	35	FL Apalachicola	1903	1989	86
31	VA Farmville	1930	1989	59	35	FL De Funiak Springs	1896	1989	90
31	VA Fredericksburg Natl Pk	1893	1989	95	35	FL Pensacola	1879	1989	110
					35	LA Amite	1882	1989	99
31	VA Hot Springs	1892	1989	95	35	LA Baton Rouge	1888	1989	102

Region	Station	Begin	End	Number
35	LA Covington	1892	1989	96
35	LA Donaldsonville	1888	1989	101
35	LA Franklin	1892	1989	95
35	LA Houma	1888	1989	100
35	LA Jennings	1897	1989	92
35	LA Lafayette	1884	1989	101
35	LA New Orleans	1888	1989	99
35	LA Thibodaux	1884	1989	103
35	MS Pascagoula	1893	1989	95
35	MS Poplarville Exp Stn	1903	1989	85
36	NC Chapel Hill	1879	1989	107
36	NC Hendersonville	1898	1989	91
36	NC Lenoir	1871	1989	118
36	NC Marshall	1899	1989	88
36	NC Morganton	1889	1989	99
36	NC Mount Airy	1889	1989	100
36	NC Reidsville	1901	1989	88
36	NC Salisbury	1882	1989	102
36	NC Statesville	1901	1989	87
36	SC Greer	1884	1989	106
36	VA Danville	1891	1989	92
37	MI Chatham Exp Farm	1900	1989	89
37	MI Cheboygan	1890	1989	100
37	MI Fayette	1920	1989	68
37	MI Newberry	1897	1989	91
38	ME Houlton	1902	1989	85
38	ME Lewiston	1886	1989	103
38	ME Millinocket	1903	1989	87
38	ME Portland	1864	1989	125
38	ME Presque Isle	1909	1989	79
38	ME Woodland	1917	1989	70
39	AR Mena	1887	1989	102
39	AR Ozark	1916	1989	72
39	AR Subiaco	1897	1989	91
39	OK Antlers	1917	1989	67
39	OK Ardmore	1901	1989	87
39	OK Durant	1901	1989	87
39	OK Hugo	1913	1989	75
39	OK Poteau	1917	1989	69
39	TX Gainesville	1889	1989	99
39	TX Greenville	1900	1989	88
40	WI Hancock Exp Farm	1902	1989	86
40	WI Hatfield	1908	1989	80
40	WI Marshfield Exp Farm	1913	1989	77
40	WI New London	1896	1989	93
40	WI Stanley	1903	1989	84
41	AR Mammoth Spring	1905	1989	81
41	IL Anna	1896	1989	94
41	IL Duquoin	1891	1989	99
41	IL McLeansboro	1882	1989	106
41	IL Mt Vernon	1895	1989	94
41	IL Olney	1887	1989	100
41	IL Sparta	1887	1989	103
41	MO Farmington	1878	1989	112
41	MO Marble Hill	1893	1989	96
42	AR Eureka Springs	1902	1989	87
42	AR Fayetteville Exp Stn	1890	1989	99
42	AR Gravette	1898	1989	91
42	MO Lebanon	1890	1989	98
42	MO Mountain Grove	1901	1989	89
42	OK Muskogee	1899	1989	89
42	OK Tahlequah	1913	1989	72
42	OK Webbers Falls	1900	1989	86
43	MI Champion	1898	1989	89
43	MI Iron Mtn	1899	1989	88
43	MI Ironwood	1901	1989	87
43	MI Stambaugh	1896	1989	91
43	MN Chaska	1892	1989	98
43	MN Cloquet	1911	1989	78
43	MN Farmington	1888	1989	102
43	MN Minneapolis	1836	1989	153
43	MN Mora	1904	1989	85
43	MN Saint Peter	1893	1989	93
43	MN Two Harbors	1894	1989	96
43	MN Zumbrota	1903	1989	85
43	WI Ashland Exp Farm	1900	1989	90
43	WI Bowler	1894	1989	92
43	WI Medford	1889	1989	100
43	WI Minocqua	1903	1989	84
43	WI Oconto	1890	1989	99
43	WI Spooner Exp Farm	1894	1989	94
44	OK Altus	1913	1989	76
44	OK Carnegie	1914	1989	75
44	OK Erick	1904	1989	84
44	OK Geary	1911	1989	78
44	OK Guthrie	1893	1989	96
44	OK Hennessey	1895	1989	91
44	OK Hobart	1903	1989	84
44	OK Kingfisher	1897	1989	92
44	OK Lawton	1912	1989	77
44	OK Mangum Rsrch Station	1892	1989	94
44	OK Meeker	1894	1989	89
44	OK Okeene	1903	1989	84
44	OK Pauls Valley	1900	1989	84
44	OK Stillwater	1893	1989	95
44	OK Waurika	1910	1989	79
44	OK Weatherford	1901	1989	86
44	TX Quanah	1904	1989	84
45	MN Detriot Lks	1895	1989	94
45	MN Eveleth	1893	1989	95
45	MN Itasca	1911	1989	78
45	MN Leech Lk Dam	1887	1989	102
45	MN Park Rapids	1893	1989	97
45	MN Pine Rvr Dam	1887	1989	103
45	MN Pokegama Dam	1887	1989	103
45	MN Sandy Lake Dam	1892	1989	98
45	MN Walker	1907	1989	82
45	MN Winnibigoshish Dam	1887	1989	102
46	IA Clinton	1878	1989	111
46	IL Dixon	1892	1989	97
46	IL Galva	1893	1989	96
46	IL Griggsville	1882	1989	108
46	IL Jacksonville	1895	1989	94
46	IL La Harpe	1895	1989	93
46	IL Lincoln	1906	1989	82
46	IL Monmouth	1893	1989	96
46	IL Morrison	1895	1989	93
46	IL Mt Carroll	1895	1989	94
46	IL Rushville	1900	1989	90
46	IL Walnut	1892	1989	98

Region	Station	Begin	End	Number	Region	Station	Begin	End	Number
46	IL White Hall	1902	1989	86	51	MN Pipestone	1898	1989	88
46	MO Bowling Grn	1898	1989	92	51	NE Ashland	1883	1989	102
46	MO Jefferson City	1891	1989	99	51	NE Auburn	1891	1989	98
46	MO Mexico	1893	1989	96	51	NE Beatrice	1891	1989	98
46	MO Steffenville	1897	1989	92	51	NE Crete	1880	1989	110
47	IN Goshen	1914	1989	73	51	NE David City	1888	1989	100
47	IN Laporte	1897	1989	92	51	NE Fairbury	1875	1989	114
47	MI Adrian	1878	1989	112	51	NE Fairmont	1894	1989	94
47	MI Allegan	1888	1989	98	51	NE Geneva	1890	1989	99
47	MI Ann Arbor	1880	1989	109	51	NE Hartington	1891	1989	97
47	MI Coldwater	1897	1989	92	51	NE Hebron	1886	1989	104
47	MI Hillsdale	1897	1989	91	51	NE Madison	1894	1989	94
47	MI Owosso	1896	1989	90	51	NE Pawnee City	1902	1989	85
48	IA Albia	1891	1989	95	51	NE Seward	1890	1989	98
48	IA Belle Plaine	1889	1989	100	51	NE Syracuse	1883	1989	104
48	IA Fairfield	1908	1989	80	51	NE Tecumseh	1878	1989	108
48	IA Fayette	1888	1989	101	51	NE Tekamah	1890	1989	97
48	IA Indianola	1890	1989	96	51	NE Wakefield	1894	1989	95
48	IA Mt Pleasant	1875	1989	112	51	NE Weeping Wtr	1878	1989	107
48	IA Washington	1882	1989	107	51	ND Fullerton	1898	1989	92
48	IL Aledo	1901	1989	89	51	OK Bartlesville	1908	1989	80
48	MO Spickard	1895	1989	95	51	OK Buffalo	1913	1989	75
48	WI Prairie Du Chien	1891	1989	99	51	OK Cherokee	1915	1989	65
49	IA Algona	1891	1989	99	51	OK Enid	1900	1989	85
49	IA Charles City	1890	1989	100	51	OK Hammon	1913	1989	76
49	IA Esterville	1895	1989	91	51	OK Jefferson	1894	1989	94
49	IA Forest City	1894	1989	93	51	OK Mutual	1907	1989	82
49	IA Fort Dodge	1900	1989	88	51	OK Pawhuska	1906	1989	83
49	IA Iowa Falls	1892	1989	96	51	OK Perry	1898	1989	87
49	IA Logan	1866	1989	122	51	SD Aberdeen	1890	1989	99
49	IA New Hampton	1897	1989	92	51	SD Academy	1898	1989	90
49	IA Toledo	1894	1989	94	51	SD Alexandria	1889	1989	93
49	MN Albert Lea	1892	1989	96	51	SD Canton	1916	1989	71
49	MN Fairmont	1887	1989	103	51	SD Clark	1889	1989	92
49	MN Grand Meadow	1886	1989	104	51	SD Forestburg	1891	1989	98
49	MN New Ulm	1893	1989	96	51	SD Howard	1890	1989	96
49	MN Winnebago	1894	1989	93	51	SD Mellette	1892	1989	90
50	IA Clarinda	1887	1989	102	51	SD Menno	1896	1989	91
50	IA Mount Ayr	1895	1989	93	51	SD Milbank	1889	1989	98
50	KS Atchison	1891	1989	96	51	SD Vermillion	1900	1989	86
50	KS El Dorado	1903	1989	86	51	SD Watertown	1892	1989	97
50	KS Eskridge	1906	1989	83	52	NE Bridgeport	1897	1989	91
50	KS Horton	1888	1989	100	52	NE Curtis	1908	1989	77
50	KS Lawrence	1868	1989	122	52	NE Imperial	1890	1989	97
50	KS Leavenworth	1911	1989	77	52	NE Kimball	1887	1989	101
50	KS Olathe	1930	1989	60	52	NE Lodgepole	1894	1989	90
50	KS Ottawa	1895	1989	94	53	ND Bottineau	1892	1989	96
50	KS Sedan	1885	1989	103	53	ND Jamestown	1891	1989	97
50	MO Conception	1883	1989	104	53	ND Langdon Exp Stn	1903	1989	80
51	IA Le Mars	1896	1989	93	53	ND Lisbon	1897	1989	86
51	IA Rock Rapids	1904	1989	84	53	ND Moffitt	1894	1989	93
51	IA Rockwell Cty	1893	1989	94	53	ND Napoleon	1889	1989	100
51	IA Storm Lake	1898	1989	91	53	ND Towner	1907	1989	82
51	KS Anthony	1896	1989	90	53	ND Willow City	1891	1989	98
51	KS Ellsworth	1904	1989	85	54	IN Hobart	1919	1989	69
51	KS Manhattan	1858	1989	132	54	IN Rensselaer	1900	1989	89
51	KS McPherson	1889	1989	101	54	IN Rochester	1925	1989	65
51	KS Medicine Lodge	1891	1989	94	54	IN Wheatfield	1916	1989	68
51	MN Milan	1893	1989	96	54	IN Winamac	1918	1989	71
51	MN Montevideo	1889	1989	100	55	IL Aurora	1879	1989	107
51	MN Morris Wc Exp Stn	1885	1989	103	55	IL Marengo	1856	1989	132
					55	IL Ottawa	1886	1989	97
51	MN Olivia	1892	1989	98	55	IL Pontiac	1903	1989	86

Region	Station	Begin	End	Number
55	WI Milwaukee	1891	1989	97
56	MT Chinook	1903	1989	84
56	MT Crow	1879	1989	109
56	MT Ekalaka	1897	1989	91
56	MT Flatwillow	1913	1989	76
56	MT Forks	1915	1989	75
56	MT Fort Assinniboine	1917	1989	73
56	MT Glasgow	1894	1989	92
56	MT Glendive	1889	1989	101
56	MT Huntley Exp Stn	1906	1989	82
56	MT Jordan	1930	1989	59
56	MT Malta	1909	1989	81
56	MT Mildred	1909	1989	78
56	MT Miles City	1877	1989	111
56	MT Plevna	1912	1989	76
56	MT Savage	1905	1989	84
56	ND Dickinson Exp Stn	1891	1989	98
56	ND Hettinger	1907	1989	81
56	ND Mott	1907	1989	82
56	ND New England	1894	1989	91
56	ND Richardton	1916	1989	73
56	WY Colony	1914	1989	75
56	WY Sheridan Fld Station	1893	1989	97
57	MT Augusta	1900	1989	89
57	MT Cascade	1904	1989	85
57	MT Choteau	1918	1989	72
57	MT Cut Bank	1908	1989	81
57	MT Dillon	1899	1989	91
57	MT Great Falls	1891	1989	98
57	MT Helena	1880	1989	109
57	MT Valier	1911	1989	78
57	MT White Sulphur Sprgs	1911	1989	78
58	MT Big Timber	1909	1989	78
58	MT Bozeman	1900	1989	90
58	MT Ennis	1918	1989	67
58	MT Livingston	1922	1989	66
58	MT Moccasin Exp Station	1909	1989	81
58	MT Norris	1907	1989	82
58	MT Virginia Cty	1916	1989	72
59	OR Astoria	1883	1989	107
59	WA Aberdeen	1891	1989	99
59	WA Forks	1908	1989	82
59	WA Long Beach Exp Stn	1878	1989	112
59	WA Port Angeles	1883	1989	107
59	WA Raymond	1895	1989	91
60	OR Three Lynx	1923	1989	66
60	WA Cedar Lake	1904	1989	86
60	WA Longmire Rainier Nps	1909	1989	81
61	UT Kanab	1911	1989	78
61	UT Modena	1901	1989	89
61	UT Saint George	1878	1989	112
61	UT Zion Natl Pk	1904	1989	82
62	UT Deseret	1899	1989	90
62	UT Elberta	1902	1989	88
62	UT Scipio	1894	1989	95
62	UT Utah Lk Lehi	1908	1989	80
63	MT Medicine Lk	1928	1989	60
63	MT Poplar	1895	1989	90
63	ND Crosby	1907	1989	81
63	ND Dunn Center	1918	1989	72
63	ND Mandan Exp Stn	1913	1989	76
64	ID Hollister	1908	1989	80
64	ID Lifton	1919	1989	70
64	ID Malad City	1913	1989	74
64	ID Oakley	1893	1989	96
64	UT Corinne	1870	1989	116
64	UT Heber	1893	1989	97
64	UT Laketown	1900	1989	90
64	UT Logan	1890	1989	98
64	UT Morgan	1911	1989	79
64	UT Ogden	1870	1989	119
64	UT Riverdale	1914	1989	75
64	UT Snake Creek	1913	1989	76
64	UT Tooele	1896	1989	93
64	UT Woodruff	1923	1989	66
64	WY Alta	1909	1989	80
64	WY Border	1902	1989	88
65	MT Hebgen Dam	1904	1989	83
65	MT West Yellowstone	1905	1989	81
65	WY Lake Yellowstone	1920	1989	65
65	WY Moran	1911	1989	78
65	WY Yellowstone Park	1889	1989	101
66	CO Cheyenne Wells	1897	1989	90
66	CO Eads	1916	1989	67
66	CO Fort Morgan	1895	1989	95
66	CO Las Animas	1867	1989	122
66	KS Oberlin	1887	1989	102
66	KS St Francis	1908	1989	81
66	OK Boise City	1925	1989	64
66	WY Basin	1917	1989	73
66	WY Cheyenne	1871	1989	119
66	WY Chugwater	1900	1989	89
66	WY Diversion Dam	1913	1989	74
66	WY Midwest	1922	1989	66
66	WY Pavillion	1919	1989	70
66	WY Powell Fld Station	1907	1989	82
66	WY Riverton	1918	1989	70
66	WY Torrington Exp Farm	1922	1989	68
66	WY Wheatland	1911	1989	76
66	WY Worland	1918	1989	72
67	CO Boulder	1897	1989	91
67	CO Fort Collins	1879	1989	109
67	WY Laramie	1890	1989	99
67	WY Pathfinder Dam	1899	1989	91
67	WY Saratoga	1906	1989	79
68	OR Brookings	1912	1989	77
68	OR Newport	1891	1989	96
68	OR North Bend	1902	1989	87
69	UT Fillmore	1892	1989	98
69	UT Levan	1889	1989	100
69	UT Manti	1893	1989	97
69	UT Spanish Fork	1909	1989	80
70	ID Challis	1913	1989	76
70	ID Salmon	1906	1989	78
70	MT Anaconda	1905	1989	84
70	MT Fortine	1906	1989	82
70	MT Hamilton	1928	1989	61
70	MT Kalispell	1896	1989	93

Region	Station	Begin	End	Number
70	MT Philipsburg	1903	1989	86
70	MT St Ignatius	1908	1989	81
71	AZ Ajo	1913	1989	77
71	AZ Buckeye	1890	1989	98
71	AZ Holbrook	1902	1989	87
71	AZ Kingman	1901	1989	87
71	AZ Mesa Exp Fm	1914	1989	76
71	AZ Sacaton	1908	1989	81
71	AZ Safford	1898	1989	90
71	AZ Selingman	1904	1989	81
71	AZ Tucson	1874	1989	116
71	AZ Wickenburg	1908	1989	81
72	AZ Childs	1915	1989	74
72	AZ Douglas	1903	1989	86
72	AZ Fort Valley	1909	1989	79
72	AZ Grand Canyon Natl Park	1903	1989	87
72	AZ Miami	1913	1989	76
72	AZ Roosevelt	1905	1989	85
72	AZ Tombstone	1897	1989	93
72	AZ Williams	1902	1989	84
73	NM Bell Ranch	1899	1989	91
73	NM Clayton	1909	1989	81
73	NM Fort Sumner	1908	1989	82
73	NM Roswell	1893	1989	97
73	NM San Jon	1907	1989	83
73	NM Santa Rosa	1908	1989	82
73	NM Springer	1903	1989	87
73	NM Tucumcari	1905	1989	85
73	TX Boys Ranch	1923	1989	66
73	TX Muleshoe	1921	1989	68
73	TX Plainview	1894	1989	96
73	TX Seminole	1922	1989	62
73	TX Stratford	1929	1989	60
74	NM Carrizozo	1908	1989	82
74	NM Elephant Butte Dam	1907	1989	82
74	NM Jornada Exp Range	1914	1989	76
74	NM Mountain Pk	1928	1989	62
74	NM Orogrande	1909	1989	81
74	NM Socorro	1891	1989	98
74	NM State Univ	1886	1989	103
74	TX Alpine	1929	1989	60
74	TX El Paso	1878	1989	112
75	UT Alton	1915	1989	74
75	UT Beaver	1904	1989	84
75	UT Escalante	1916	1989	71
75	UT Loa	1921	1989	68
75	UT Panguitch	1907	1989	83
75	UT Richfield	1897	1989	93
76	UT Bluff	1918	1989	71
76	UT Ft Duchesne	1887	1989	102
76	UT Green River	1898	1989	90
76	UT Hanksville	1910	1989	80
76	WY Green River	1904	1989	85
77	CO Fruita	1902	1989	85
77	CO Montrose	1885	1989	105
77	NM Aztec Ruins Natl Mon	1910	1989	80
77	UT Blanding	1904	1989	84
77	UT Duchesne	1906	1989	84
77	UT Hiawatha	1916	1989	73
77	UT Moab	1889	1989	98
77	UT Thompson	1918	1989	72
77	UT Vernal	1928	1989	61
78	AZ Parker	1893	1989	97
78	AZ Yuma	1901	1989	69
78	CA Blythe	1909	1989	81
78	CA Needles	1888	1989	99
78	NV Searchlight	1914	1989	76
79	AZ Saint Johns	1909	1989	81
79	NM Fort Bayard	1885	1989	105
79	NM Luna	1900	1989	90
79	NM Mountainair	1926	1989	64
80	CO Durango	1894	1989	96
80	CO Hermit	1903	1989	86
80	CO Telluride	1911	1989	78
80	NM Chama	1905	1989	84
80	NM Cimarron	1904	1989	85
80	NM Jemez Springs	1910	1989	80
80	NM Las Vegas	1891	1989	99
80	NM Red River	1906	1989	84
81	CO Canon City	1888	1989	99
81	CO Del Norte	1919	1989	68
81	CO Saguache	1894	1989	92
82	CA Electra	1903	1989	86
82	CA Fresno	1877	1989	112
82	CA Hanford	1899	1989	91
82	CA Lemon Cove	1899	1989	91
82	CA Merced	1872	1989	117
82	CA Paso Robles	1886	1989	103
82	CA San Luis Obispo	1869	1989	120
82	CA Tejon Rancho	1908	1989	82
82	CA Wasco	1899	1989	90
83	CA Brawley	1909	1989	81
83	CA Death Valley	1911	1989	78
83	CA Independence	1892	1989	98
84	NV Austin	1910	1989	80
84	NV Battle Mtn	1870	1989	119
84	NV Elko	1870	1989	120
84	NV Fallon Exp Station	1903	1989	87
84	NV Lovelock	1916	1989	73
84	NV McGill	1911	1989	79
84	NV Mina	1896	1989	94
84	NV Reno	1870	1989	120
84	NV Winnemucca	1870	1989	120
84	UT Wendover	1911	1989	78
85	CA Avalon	1909	1989	80
85	CA Fairmont	1909	1989	81
85	CA Ojai	1905	1989	84
85	CA Pasadena	1908	1989	81
85	CA Santa Barbara	1867	1989	119
85	CA Tustin	1877	1989	113
86	ID Coeur D'Alene	1913	1989	75
86	ID Porthill	1889	1989	100
86	ID Sandpoint Exp Stn	1910	1989	79
86	MT Haugan	1911	1989	79
86	WA Spokane	1880	1989	110
87	ID Arrowrock Dam	1911	1989	78
87	ID Caldwell	1904	1989	85
87	ID Cambridge	1901	1989	88
87	ID New Meadows	1903	1989	86
87	ID Payette	1927	1989	62

Region	Station	Begin	End	Number	Region	Station	Begin	End	Number
87	OR Vale	1919	1989	71	95	CA Orleans	1903	1989	87
88	ID Aberdeen Exp Stn	1914	1989	75	95	CA Weaverville	1912	1989	78
88	ID Ashton	1897	1989	92	95	CA Yreka	1913	1989	76
88	ID Glenns Ferry	1909	1989	80	95	OR Ashland	1879	1989	110
88	ID Grace	1907	1989	83	95	OR Grants Pass	1889	1989	101
88	ID Hazelton	1917	1989	72	95	OR Prospect	1905	1989	84
88	ID Jerome	1915	1989	74	96	ID Fenn Ranger Stn	1908	1989	81
88	ID Ketchum Ranger Stn	1909	1989	81	96	ID Lewiston	1893	1989	97
					96	WA Pomeroy	1891	1989	98
88	ID Mackay	1908	1989	81	97	OR Cascadia	1908	1989	82
88	OR Danner	1929	1989	59	97	OR Cottage Grove	1916	1989	73
89	OR Corvallis	1889	1989	101	97	OR Headworks Portland Wtrb	1899	1989	91
89	OR Forest Grove	1916	1989	73					
89	OR Riddle	1913	1989	77	97	WA Blaine	1902	1989	88
89	OR Roseburg	1877	1989	112	97	WA Buckley	1913	1989	77
90	CA Cedarville	1894	1989	95	97	WA Centralia	1901	1989	89
90	OR Bend	1902	1989	88	97	WA Clearbrook	1903	1989	86
90	OR Bly	1920	1989	66	97	WA Longview	1925	1989	65
90	OR Klamath Falls	1896	1989	94	97	WA Sedro Woolley	1896	1989	93
90	OR Lakeview	1890	1989	99	97	WA Snoqualmie Falls	1898	1989	92
90	OR Paisley	1925	1989	63	97	WA Vancouver	1898	1989	91
91	WA Cle Elum	1899	1989	91	98	WA Davenport	1909	1989	81
91	WA Conconully	1899	1989	90	98	WA Waterville	1890	1989	100
91	WA Stehekin	1916	1989	71	98	WA Wilbur	1899	1989	91
91	WA Wenatchee	1912	1989	77	99	WA Bellingham	1895	1989	94
91	WA Winthrop	1909	1989	81	99	WA Everett	1914	1989	75
92	OR Dufur	1909	1989	81	99	WA Grapeview	1907	1989	83
92	OR Hood River Exp Stn	1884	1989	106	99	WA Olga	1890	1989	100
					99	WA Pt Townsend	1873	1989	115
92	WA Goldendale	1905	1989	85	99	WA Puyallup Exp Stn	1914	1989	76
93	CA Colfax	1870	1989	120	99	WA Seattle	1909	1989	81
93	CA Lk Spaulding	1895	1989	95	100	ID Priest Rvr Exp Stn	1911	1989	78
93	CA Quincy	1895	1989	95	100	MT Libby	1910	1989	80
93	CA Susanville	1927	1989	62	100	WA Colville	1899	1989	89
93	CA Tahoe City	1909	1989	80	100	WA Northport	1910	1989	80
93	CA Yosemite Park Headquarters	1904	1989	85	101	OR Baker	1889	1989	100
					101	OR Union Exp Stn	1911	1989	79
94	CA Berkeley	1886	1989	102	101	OR Wallowa	1903	1989	87
94	CA Chico	1870	1989	118	102	OR Condon	1907	1989	83
94	CA Davis	1871	1989	118	102	OR Heppner	1889	1989	100
94	CA Healdsburg	1876	1989	113	102	OR Pilot Rock	1908	1989	82
94	CA Livermore	1870	1989	119	102	OR Prineville	1897	1989	93
94	CA Lodi	1926	1989	62	103	OR Hermiston	1906	1989	83
94	CA Marysville	1871	1989	116	103	OR Milton-Freewater	1914	1989	76
94	CA Napa	1916	1989	74	103	OR Moro	1910	1989	80
94	CA Orland	1883	1989	107	103	WA Ellensburg	1892	1989	98
94	CA Petaluma	1913	1989	76	103	WA Kennewick	1894	1989	90
94	CA Redding	1875	1989	115	103	WA Odessa	1903	1989	87
94	CA Santa Cruz	1873	1989	115	103	WA Ritzville	1899	1989	90
94	CA Santa Rosa	1888	1989	100	103	WA Sunnyside	1894	1989	95
94	CA Ukiah	1877	1989	113	103	WA Walla Walla	1873	1989	117
94	CA Vacaville	1880	1989	110	104	ID Dworshak Fish Hatchery	1903	1989	86
94	CA Willows	1878	1989	111					
95	CA Eureka	1885	1989	105	104	ID Moscow	1892	1989	98
95	CA Fort Bragg	1895	1989	94	104	WA Colfax	1892	1989	98
95	CA Happy Camp Ranger Stn	1927	1989	62	104	WA Dayton	1891	1989	92
					104	WA Pullman	1893	1989	97

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